1. Introduction
As the market for bio-based plastics increases, alternative feedstocks need to be found. Limonene, the main constituent of orange peel, is one of these. Its epoxides can be used to produce polycarbonates and polyurethanes, but process intensification for producing these epoxides on an industrial scale using a benign method is yet to be investigated.

Process intensification involves the substantial improvement of a manufacturing process, either by improved energy efficiency, cost-effectiveness, or other qualities such as improved reaction rates, reduced waste production and improved purification steps. The spinning cloth disc reactor is a novel reactor suitable for enzyme-catalysed reactions that exhibits properties associated with process intensification. This is the first reported use of the reactor for a multi-step reaction.

2. Spinning Cloth Disc Reactor

3. Enzyme-Catalysed Epoxidation of Limonene

- Enzymes require Ser-His-Asp group in order to catalyse perhydrolysis.
- Most enzymes favour hydrolysis over perhydrolysis as the carbonyl group isn’t present.

Solution: 470 mL octanoic acid
240 mL limonene
280 mL hydrogen peroxide solution (30 wt%)

Mass Flow Rate: 1.8 g s⁻¹
Disc Rotation: 50 RPM
Temperature: 20 °C
Enzyme: amano lipase PS from B. cepacia

4. Enzyme Loading

5. Results: Reaction?

6. Effect of Reaction on Cloth

7. Conclusions & Future Work

Reaction successfully carried out without solvent, with a total epoxide yield of 95% after 38 hours. Higher diepoxide yield, 19.4 %, achieved than that reported for batch reaction, 14.6 % after 24 hours. Investigation into alternative enzyme supports, and potentially immobilisation method, required. Reactor needs to be redesigned in order to minimise volumetric loss and allow enzyme to function at optimal temperature. Deconstruction of reaction necessary in order to accurately calculate rate kinetics, with comparisons made to batch reactions.

References